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An Evaluation of the Proposed Average-Strength Scheme

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INTRODUCTION AND SUMMARY

Early in FY00, the U.S. Army asked each of the other services to consider joining it in proposing, through the Unified Legislative and Budgeting (ULB) process, legislation that would change the military's personnel target from an end-strength goal to a goal based on average strength, calculated across the fiscal year. The Deputy Chief of Naval Operations, Manpower and Personnel (N1) asked the Center for Naval Analyses to evaluate the average-strength scheme to help the U.S. Navy formulate its response to the Army. We provided the N1 staff an earlier draft of this report that raised concerns about the scheme (as this final version of the report continues to do). The Navy shared the draft report with the Army, which decided not to continue pursuing the proposal.

As we understand it, Army personnel planners were proposing this change primarily as a way to increase end-strength and associated personnel funding. Because average-strength has always been less than end-strength, setting an average-strength target at the level of current end-strength would raise end-strength and would require an increase in personnel funding.

Some members of the N1 staff advocated supporting the proposed legislation if the analysis showed that the average-strength scheme would eliminate current incentives that favor bringing in a relatively high percentage of recruits late in the fiscal year. At present, the military can save on personnel costs by drawing down strength in the beginning and middle of the fiscal year. In addition, recruiting command finds that it is easier to recruit students who are about to graduate from high school than persons already in the workforce (the quality of high school recruits is higher than workforce recruits and it is less costly to recruit from among the high school population). High school recruits typically become available only late in the fiscal year, which leads to most shippers arriving at Recruit Training Command (RTC) between June and September.

This back-loading of accessions imposes a number of costs on the services. The accession pattern generates a "bathtub in fleet manning," which, in turn, has a detrimental effect on readiness. Also, concentrating accessions within a few months increases the amount of infrastructure necessary to train recruits. Finally, to the extent that peak-load accessions exceed the services' training capacity, back-loading increases the number of personnel who are awaiting instruction and who are either idle or less than fully employed.

On its face, the idea of changing to an end-strength goal seems desirable. Under such a scheme, the amount paid to a recruit would be proportional to the contribution he or she makes to achieving the strength goal: compared to someone who ships in October, a person who ships in the following September would receive 1/12 the pay, and would contribute 1/12 the person-months to meeting the average-strength goal. Such a scheme would eliminate the services' ability to save on personnel costs by drawing down on midyear strength. Moreover, as we will show, an average-strength scheme would create an incentive for recruiters to send as many persons as possible to boot camp early in the fiscal year. (The scheme would not, of course, affect the supply of recruits; the majority of high school graduates would still become available late in the fiscal year.)

Despite these advantages, our analysis finds serious shortcomings to an average-manning scheme. We have used staffing simulations to predict the potential effects of an average-strength scheme on current strength, accession patterns, and the quality of recruits. We found important obstacles to implementing such a plan, including the following:

- The *variation* in late-year shippers would sharply increase, likely causing inefficiencies at training command as it adjusts to changing accession plans. This is because, under the average-strength scheme, unexpected changes in strength early in the fiscal year require large corrections late in the fiscal year.

- Under an average-strength scheme, shortfalls in recruiting could produce large, multi-year oscillations in both current strength and the accession pattern.

- Establishing a "margin of error" around an average-strength goal would be a more complex and more critical process than setting the margin around an end-strength target.

APPROACH

This analysis is based on a series of simulations, or simple mathematical representations, that show how the introduction of an average-strength scheme could affect accessions and current strength. The simulations are predicated on various assumptions about the accession patterns; these are specified and explained in detail in the body of the report.[1] We also assume (1) that current strength is equal to 315,000 at the beginning of the year in which the average-strength scheme is introduced (this level of current strength is approximately the end-strength that prevailed for FY 1999) and (2) that losses from the Navy equal 5,200 per month and are constant over the year. This final assumption, although unrealistic, greatly simplifies the discussion of our analysis. We have taken care to ensure that the principal results of this analysis hold when we relax this assumption and use more realistic loss patterns.

In performing our analysis, we have also been attentive to the institutional arrangements through which the Navy establishes workforce targets and how it adjusts recruiting when it has either missed the early-year recruiting goal or faces different than expected retention behavior. Currently, the Navy's accession goals are given to Commander, Navy Recruiting Command (CNRC) by the Deputy Chief of Naval Operations, Manpower and Personnel (N1), using estimates generated by the Navy's strength planners. The strength planners estimate the number of losses that need to be replaced by accessions each year to meet that year's strength target. N1 also decides on the month-by-month accession goals, after consulting with CNRC on what accession patterns would be achievable for Recruiting Command. If Recruiting Command misses the goal for a given month of the year, N1 decides (after consulting with CNRC) where to rephase that goal into the remaining portion of the year. Under an average-strength scheme, however, the choice of accession pattern and the choice of pattern for rephasing missed goals

[1] To simplify the modeling and the interpretation of the results, we use accessions that are level-loaded throughout the year in many of our simulations. However, in the appendix to this report, we demonstrate that the key findings of our work are valid whether we simulate the operation of the average-strength scheme under level-loaded accessions or under patterns of accessions similar to those of the last few years.

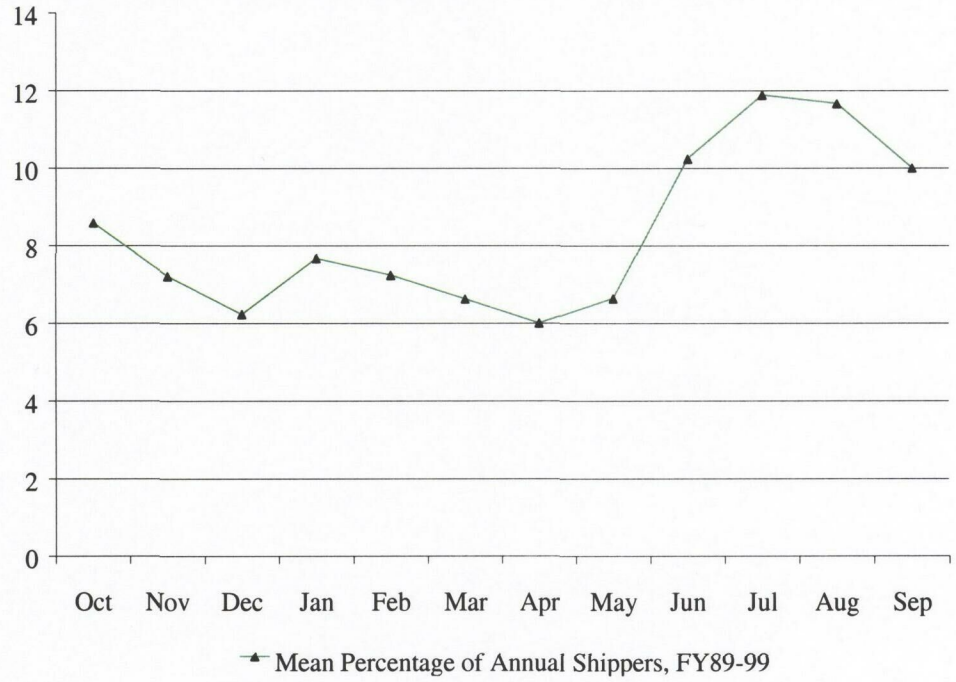
have a large impact on that year's overall accession goal and on subsequent years' accession goals. Therefore, we simulate both within-year and across-year effects in this paper.

WOULD THE INTRODUCTION OF AN AVERAGE-STRENGTH SCHEME ELIMINATE THE BACK-LOADING OF ACCESSIONS?

Introduction of an average-strength scheme would eliminate only <u>one</u> of the forces that drives the back-loading of accessions; thus, it is uncertain whether it would reduce the summer peak in shipping.

Over the last ten years, the accession profile has shown a high summer peak. Figure 1 illustrates that, over this period, monthly accessions in each of the last four months of the fiscal year (June to September) have averaged more than 10 percent of total annual accessions. In contrast, monthly accessions in March, April, and May have averaged less than 7 percent of total annual accessions.

Figure 1. Monthly accessions as a percentage of total annual accessions for 1989–99



Both availability of recruits and cost of recruits contribute to this end-loading of accessions. Regarding availability of recruits, the services have typically recruited a large proportion of their personnel from among new high school graduates, and the summer peak in recruiting is correlated with high school graduation schedules. On the cost side, ongoing CNA work suggests that the average recruiting cost of a high school recruit in peak season is considerably less than the cost of the same-quality workforce recruit. This suggests that significantly less effort must be expended to recruit persons from high school who ship during June to September.

In addition, the services have an incentive to ship recruits toward the end of the fiscal year to create savings in the personnel budget. Ignoring first-year attrition, a recruit who ships in September (the last month of the fiscal year) contributes just as much to meeting end-of-year goals as one who ships in October (the first month of the fiscal year).[2] The early shipper, however, must be paid for an entire year; the late shipper can be paid for only one month.

Under the proposed legislation, the services would be charged with maintaining some specified level of average strength, calculated over the fiscal year. One benefit of this plan is that the contribution made by a recruit to achieving the average-strength goal would be proportional to the amount paid to the recruit: compared to someone who ships in October, a person who ships in the following September would receive 1/12 the pay, and would contribute 1/12 the person-months to meeting the average-strength goal. Establishing such a strict proportionality between the amount paid to a recruit and the amount he or she contributes to meeting the average-strength target would eliminate the ability of the services to save on personnel costs by drawing down on strength early in the year and would eliminate one of the possible causes of the bathtub in fleet manning. However, it would do nothing to the seasonal pattern of availability of recruits or to the seasonal differences in recruiting cost per recruit.

WOULD THE INTRODUCTION OF AN AVERAGE-STRENGTH SCHEME AFFECT THE QUALITY OF RECRUITS?

An average-strength scheme could result in a deterioration in the quality of recruits.

The fact that a contract signed in the last month of the fiscal year has only 1/12 the effect on meeting the average-year staffing requirement of a contract signed in the first month of the fiscal year implies that each additional recruit who can be shipped in October eliminates the need to ship 12 recruits in the following September. This may or may not create an incentive for Navy planners to shift some recruiting goal in the fiscal year. Whether it does create this incentive depends on how Navy planners weigh tradeoffs between making this year's recruiting goal lower in exchange for making next year's goal higher.[3]

This possible incentive to front-load accessions in order to meet the average-strength goal stands in sharp contrast to the incentive to minimize recruiting costs by recruiting among high school students who typically become available only late in the fiscal year. For this reason, it is unclear whether an average-strength scheme would provide enough incentive to change the accession pattern.

However, if an average-strength scheme were to shift accessions toward the beginning of the fiscal year, there would likely be a deterioration in the quality of the recruits. Workforce recruits are more likely to ship early in the fiscal year, whereas high school recruits are more likely to ship later in the year. For this reason, under the average-strength scheme, it would make sense for recruiting to more actively solicit from the workforce population and to pay less attention to graduating high school seniors. A significant body of literature suggests that quality of recruits,

[2] If we considered attrition in our analysis, the late shipper would actually contribute more to meeting end-strength than the early shipper under an end-strength scheme.

[3] We discuss the across-year implications more fully in the next section.

measured in terms of attrition and time in DEP, is lower among those who come from the workforce than among those who come directly from high school.

UNDER AN AVERAGE-STRENGTH SCHEME, WHAT WOULD BE THE TRADEOFF BETWEEN THE TIMING OF ACCESSIONS AND THE NUMBER OF ACCESSIONS REQUIRED? WOULD THE ACCESSION GOAL BE ABOUT THE SAME FROM YEAR TO YEAR?

The more accessions that can be brought in early in the year, the lower the overall recruiting goal can be for that year, but the higher the goal has to be in the subsequent year. In fact, the introduction of an average-strength scheme would result in the ability to shift recruiting workload from one year to the next and could produce significant volatility across years in both manning and accessions.

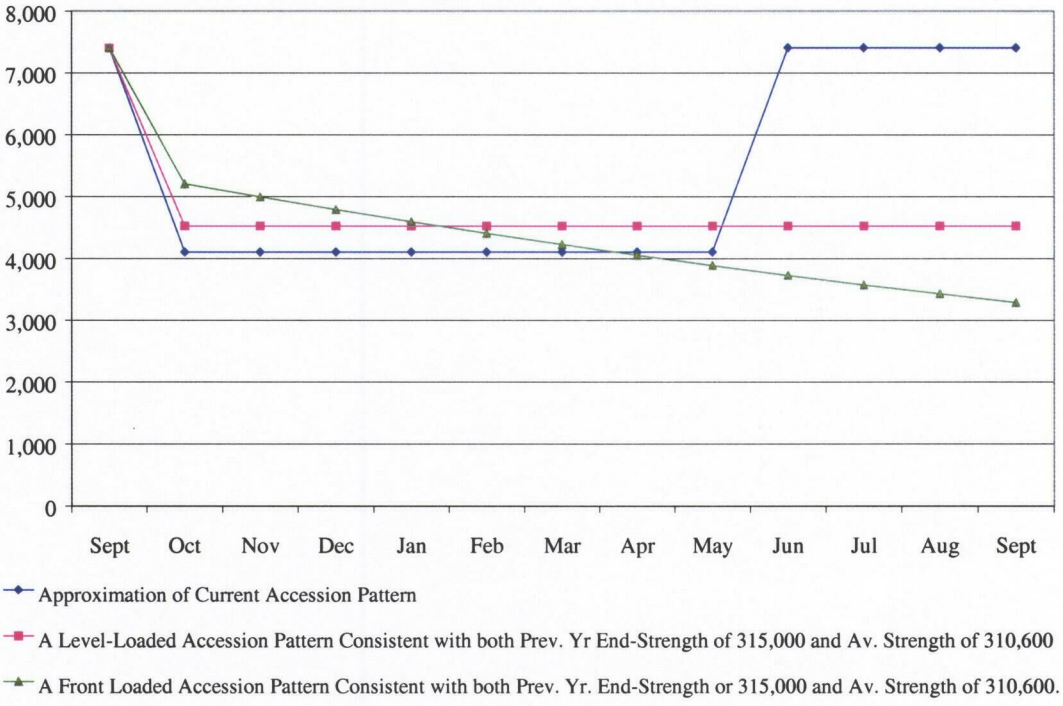
The tradeoff is demonstrated with three scenarios, presented in figure 2, panels A and B, which represent possible staffing patterns that we might observe in the first fiscal year after the introduction of an average-strength scheme. For this demonstration, we assume that this fiscal year begins with a manning level for the Navy of 315,000 (this is close to the level of end-strength for FY 1999). We also assume that policy-makers set the average-strength target for the Navy at 310,600 (this is close to the level of average-strength that would prevail with a beginning strength and end-strength of 315,000 and with the average proportional accession pattern of the last 10 years). Finally, we assume that the Recruiting Command's only objective is to meet the average-strength goal of 310,600; the Navy is not constrained to meet any current-strength target during the year.

One possible result of introducing an average-strength target is that the Navy continues recruiting as it does at present. The current back-loaded accession pattern is approximated by the dark blue line in panel A and, in this hypothetical simulation, requires 62,400 shippers to achieve the average-strength target of 310,600. Alternatively, the Navy might pursue a level-loaded accession pattern (the red curve); this achieves the average-strength goal with only 54,276 shippers. Finally, if there is a sufficient supply of recruits early in the fiscal year, the Navy might pursue a front-loaded pattern (the green curve) that requires only 50,101 shippers to achieve the average-strength target. All three of these accession patterns start with the same levels of current strength and all three meet the average-strength target of 310,600, but the accession patterns that are more front-loaded require fewer recruits to meet goal in that particular year.

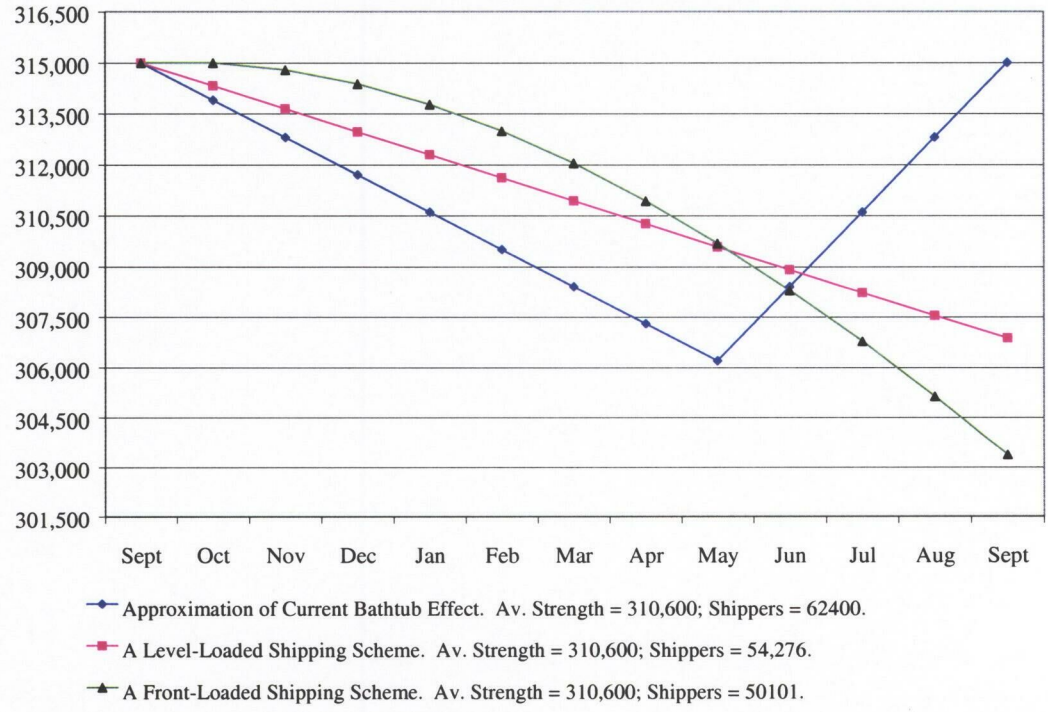
The three scenarios, presented in figure 2, panels A and B, illustrate several points that are important for understanding how an average-strength scheme would affect the stability of manning and accessions across years. First, because the target would be expressed only in terms of average strength calculated over the fiscal year, there would be no explicit requirement to achieve a specified strength level at any point during the year; the only requirement in selecting an accession pattern would be meeting the average-strength goal. The second point is that accession patterns that yield the same average strength can produce very different levels of end-strength: patterns that are more front-loaded require fewer recruits to meet an average-strength goal, so the more front-loaded accessions, the lower the end-strength. Although end-strength would not be a target under the new legislation, it would continue to have an important, implicit role

Figure 2

Panel A. Three simulated accession plans



Panel B. Current-strength levels associated with panel A. (Monthly accessions are as shown in panel A, and monthly losses equal 5,200.)



under an average-strength scheme. The reason is that the end-strength for 1 year defines the initial value from which average strength is calculated for the subsequent year.

Finally, figure 2 shows that the introduction of an average-strength scheme would create the ability to shift recruiting workload from one year to the next. In years in which the services are able to undertake relatively more recruiting early in the year—and can, therefore, meet their average-strength goal with relatively fewer recruits—they would end the year with a low level of end-strength. The services would then start the subsequent year with less manning and would have to undertake more recruiting to meet their new average-strength goal. In figure two, panel B, we see that the front-loaded pattern (the green curve) requires the fewest recruits to meet the average-strength target and produces the most severe drawdown in current strength. Compared to the level-loaded pattern, the front-loaded pattern requires 4,175 fewer recruits to meet the average-strength goal and yields an end-strength that is 3,492 less.

In subsequent sections, we illustrate in detail that several phenomena—including shifting workload from one year to the next—can create oscillations in manning and strength that last for many years. We can demonstrate the reason for this by considering the longer term implications of our present example. If the services shift workload from year 1 to year 2, they start the second year with an unusually *low* level of current strength. As a result, they would need to achieve an unusually *high* level of current strength by the end of year 2 to achieve their average-strength goal. This, in turn, implies that the services would start year 3 with an unusually high level of staffing and would need to achieve an unusually low level of strength by the end of year 3 to again meet the average-strength target. This type of oscillation could continue indefinitely.

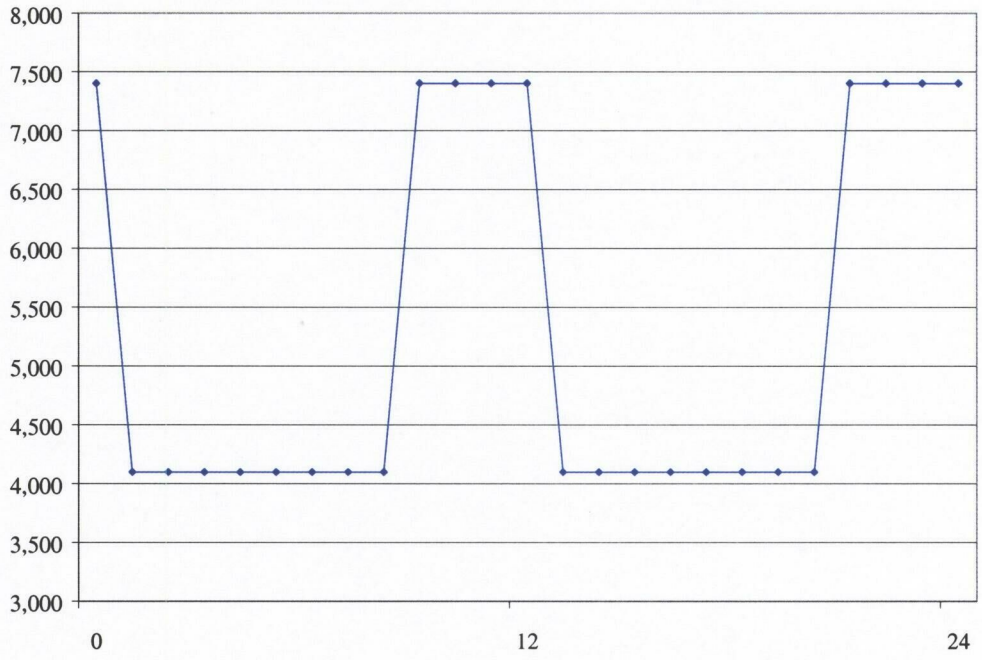
Although shifting recruiting workload from one year to the next might be desirable in specific circumstances, it seems likely that the services as a whole would wish to implement accession patterns that are roughly similar year after year. Of the accession patterns that are consistent with achieving a specific average-strength target, only a few are capable of being replicated in this fashion, and there is nothing in the proposed legislation that would require this sort of replicability.

A necessary condition for an accession pattern being replicated over consecutive years is that it must yield current strength at the end of the fiscal year that is equal to the current strength that had prevailed at the beginning of the fiscal year.[4] One obvious way to meet the condition for replicability is to maintain a constant level of planned current strength over the fiscal year. Such a case could be achieved by setting accessions equal to losses in each period. In the absence of unplanned shortfalls in recruiting, this would yield a constant current strength that would be equal to planned average strength. The necessary condition could also be achieved by allowing current strength to vary below (above) planned average strength in midyear and offsetting this by allowing current strength to be above (below) planned average strength at both the beginning and the end of the year. The approximation of the recent shipping pattern shown in figure 3, panel A, is an example of an accession path that is replicable year after year but for which average strength differs from current strength most of the time.

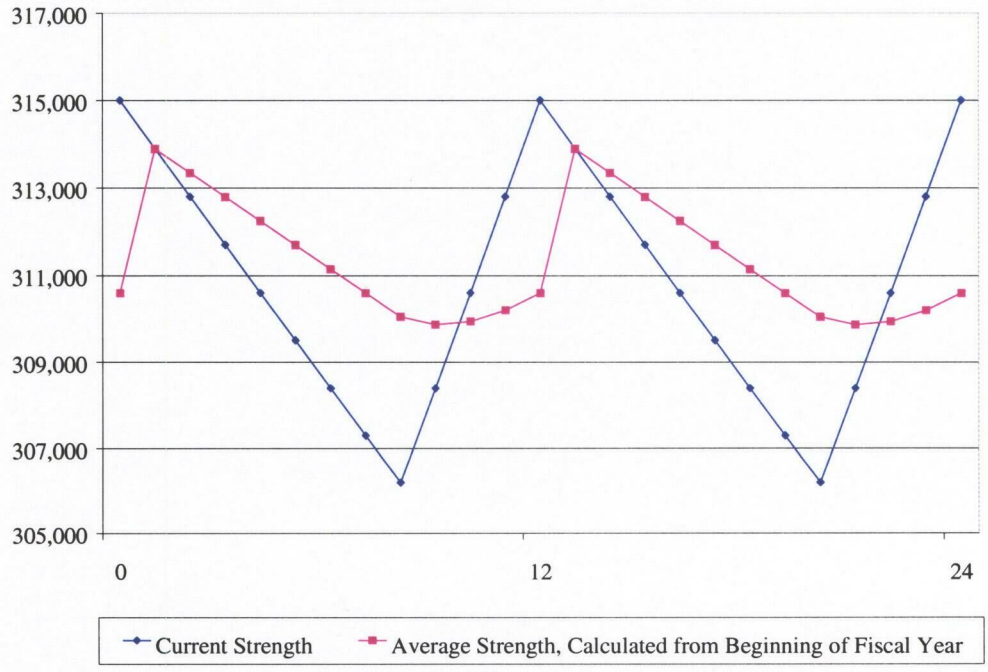
[4] This necessary condition is valid as long as a loss pattern exists that is replicated in consecutive years and as long as the average-strength goal is constant from one year to the next. The necessary condition could be modified to allow for more complex loss patterns or for an average-strength goal that is increasing or decreasing over time.

Figure 3

Panel A. An approximation of the current accession pattern



Panel B. Levels of current strength and average strength associated with the approximation of the current accession pattern



WOULD SHOCKS IN RECRUITING AND RETENTION BE MORE EASILY MANAGED UNDER AN AVERAGE-STRENGTH SCHEME?

No. Under an average-strength scheme, shortfalls in recruiting or unexpected changes in retention can produce wasteful changes in the level of current strength, greater variability in summer shipping, and multiyear oscillations in both strength and accessions.

Shocks in Recruiting or Retention Could Necessitate Wasteful Changes in the Level of Current Strength. Under the average-strength scheme, any unanticipated shock to either shipping or retention would necessitate moving current strength away from the average-strength target, and this would be wasteful of personnel resources. We illustrate this point with the simple example shown in figure 4. For this illustration, we assume that the Navy is trying to maintain end-strength and average strength at a constant level of 315,000 throughout the year, and, to do this, it maintains accessions equal to losses at 5,200. We further assume that in period 14 (the second month of the second fiscal year), an unexpected shortfall in accessions occurs: rather than shipping 5,200 in this month, only 4,200 persons begin active duty. As a consequence, current strength declines from 315,000 to 314,000. To achieve the average-strength target of 315,000 by the end of the second fiscal year, the Navy must increase its current strength levels above the 315,000 average-strength target in the latter months of this year. If the Navy is fully manned at 315,000, however, it is wasteful to raise current strength above this level.[5] Note that an unexpected rise in retention also generates an inefficient adjustment: should retention unexpectedly rise early in the year and current strength increase above the average-strength target, the service would have to reduce current strength below the average-strength target later in the year. This could have undesirable effects on readiness and force productivity.

Shocks in Recruiting or Retention Could Produce Greater Volatility in Summer Shipping. The average-strength scheme would also likely be characterized by a high degree of volatility in the number of recruits who are shipped in the last few months of the fiscal year. We have previously pointed out that shipping recruits early in the year has a far greater effect on meeting average strength than shipping recruits late in the year. To put this into concrete terms, shipping 7,500 recruits per month for the first 3 months of the fiscal year would contribute 20,625 person-months to meeting an average-strength target,[6] whereas shipping the same number in the last 3 months would contribute only 3,750 person-months.

We have previously observed that this incentive to front-load accessions stands in sharp contrast to the incentive to minimize recruiting costs by recruiting among high school students who typically become available only late in the fiscal year. In years when the services find it relatively cheap to recruit among workforce candidates (perhaps in times of high unemployment), they would likely try to meet the average-strength goal well before the end of the fiscal year and would ship relatively fewer recruits in the late summer months. Conversely, in years when it is relatively expensive to recruit from among the workforce, the services would likely experience recruiting shortfalls early in the year and would need to ship very large numbers of recruits in the summer to reach the average-strength goal.

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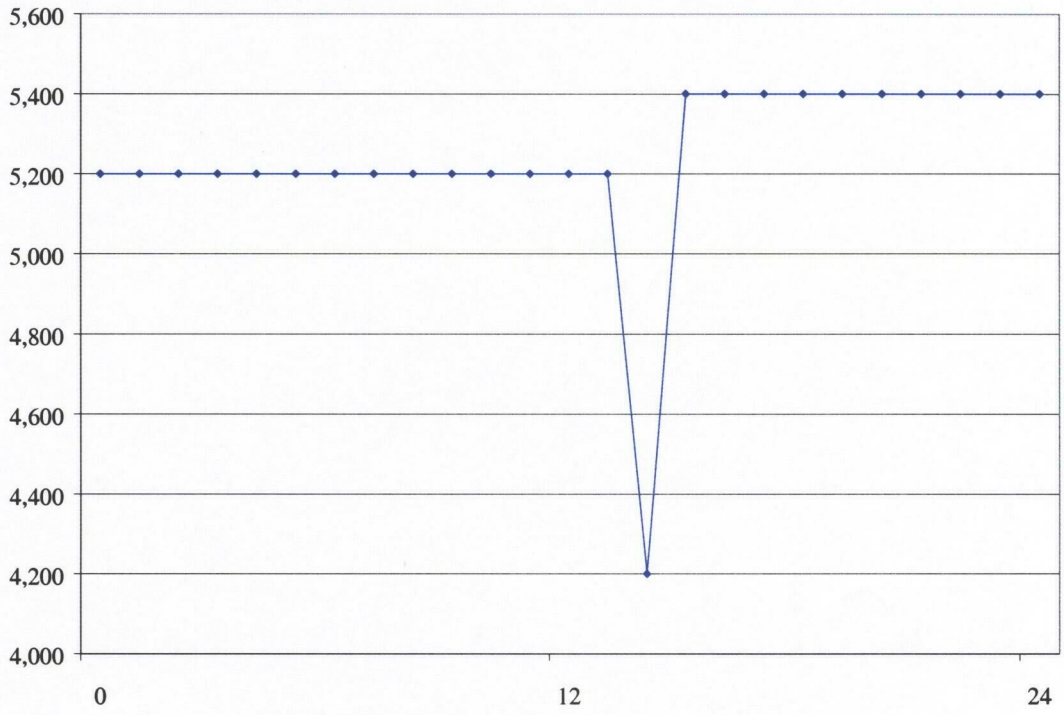
[5] This observation could be generalized to a situation in which shipping is at a peak in summer and at a nadir in winter/spring. In figure 11, panel B, in the appendix we see that a period 14 shock to recruiting results in the level of current strength in period 24 rising to 316,000. Again, if the Navy is fully manned at 315,000, it is wasteful to raise current strength above this level.

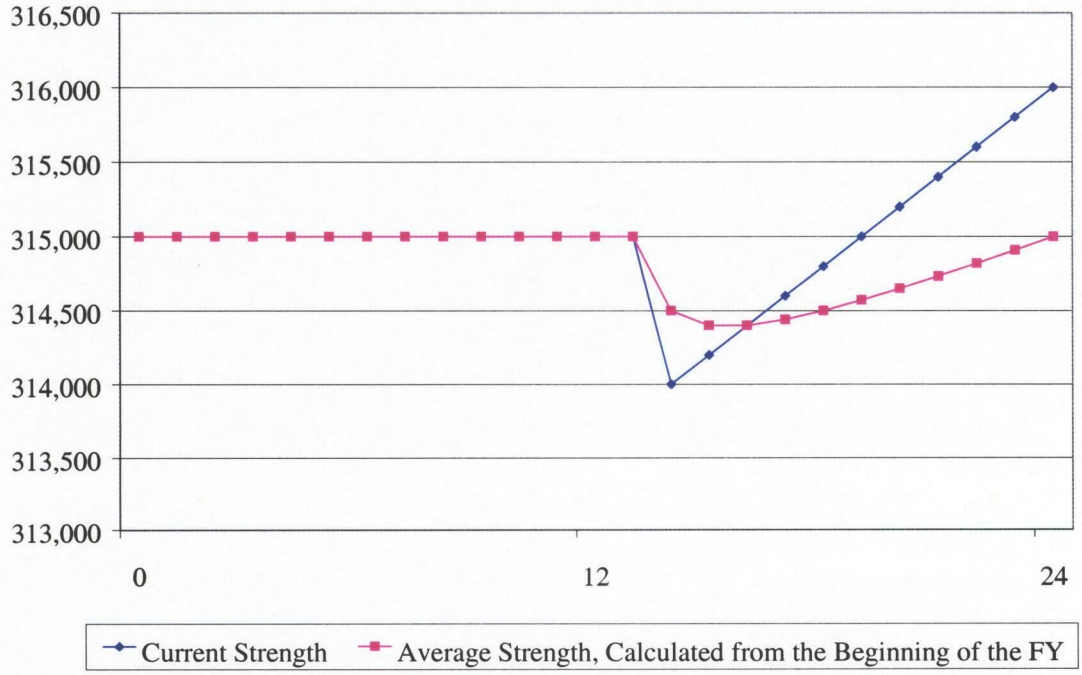
[6] This is calculated as (12/12)*7,500 + (11/12)*7,500 + (10/12)*7,500.

Figure 4

Panel A. Adjusting accessions to an unexpected shortfall in shippers



Panel B. Current strength associated with accession profile



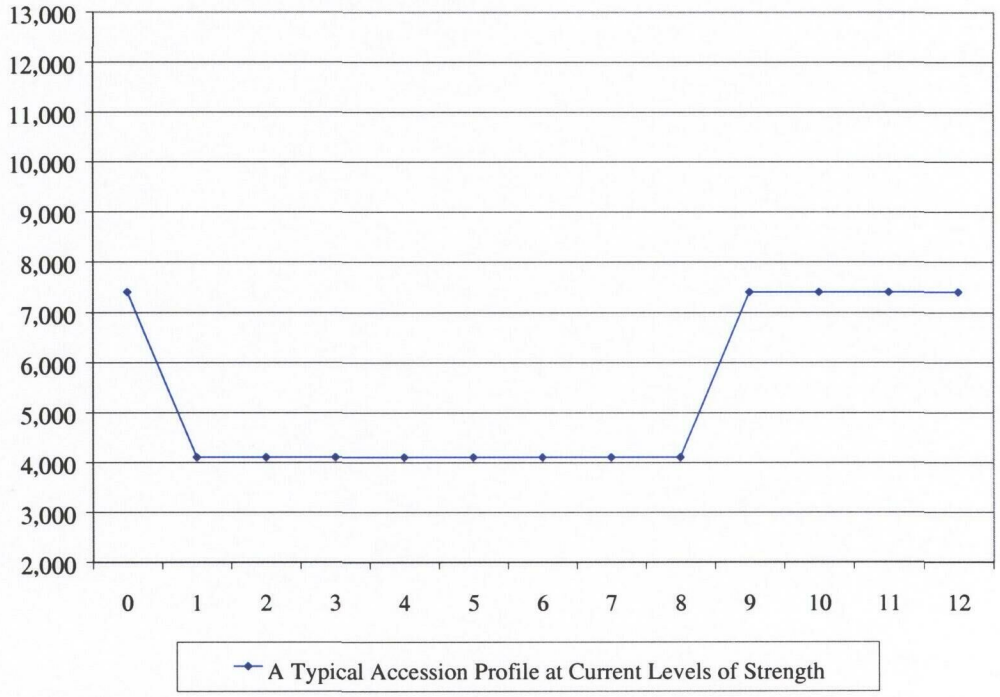
Panels A through C of figure 5 illustrate that shortfalls in recruiting similar to those experienced in 1998 would require far greater summer shipping under an average-strength target than under an end-strength manning goal.[7] As a point of reference, we show an approximation of the current accession profile in panel A: 4,100 persons are shipped in the first 8 months of the fiscal year, and 7,400 are shipped in the last 4 months. This accession pattern is consistent with a beginning strength and end-strength of 315,000 and an average strength of 310,600.[8]

Panel B shows how the services could respond to shortfalls in recruiting to meet an end-strength target: shortfalls of 1,000 recruits in each month from February (month 5) through June (month 9) are followed by 3 months in which shipping is increased to 9,007 per month (22 percent above the usual level of 7,400 recruits). Even though this rise in summer shipping is sufficient to meet the end-strength target of 315,000, average strength under this accession pattern is only 308,933.

Panel C shows an accession pattern that is consistent with meeting the average-strength goal of 310,600. After the 5 months of shortfalls, shipping increases to 12,400 for each of the last 3 months of the fiscal year (68 percent above the usual levels for these months). This increase in shipping is sufficient to raise average strength to 310,600 by the end of the year, and to increase end-strength to 325,000.

Figure 5

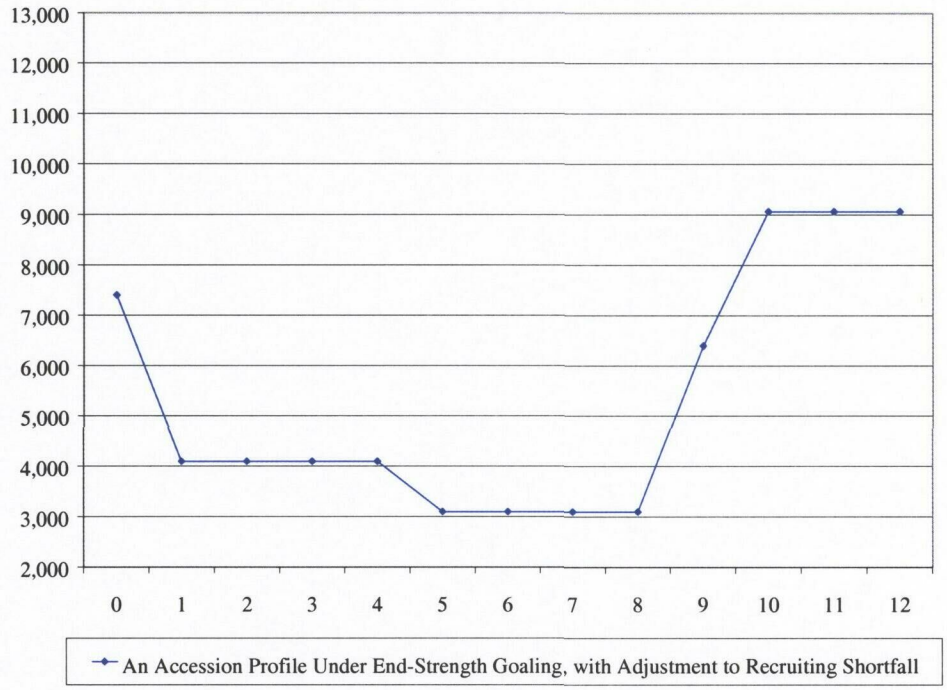
Panel A. An approximation of the current accession pattern



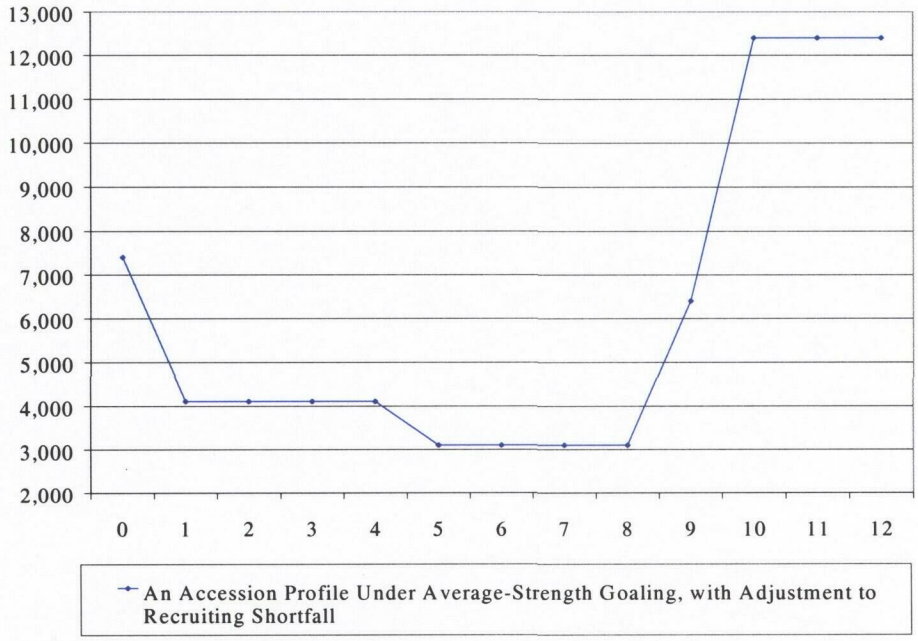
[7] Data provided by LCDR Tierney of N132C5 indicate that, for 1998, accession attainment fell short of accession goal by 699 in February, 1,141 in March, 1,384 in April, 923 in May, and 1483 in June.
[8] Implicit in this simulation is a constant monthly loss rate of 5,200.

Figure 5, Continued

Panel B. Adjustment to shortfalls in shipping under end-strength manning



Panel C. Adjustment to shortfalls in shipping under an average-strength target



A similar example could be constructed to show that a series of unplanned reductions in losses from the service would necessitate much larger reductions in shippers in the last quarter of the year under an average-strength scheme than under an end-strength scheme. This sort of "feast or famine" phenomenon would be especially difficult on military training because trainers would have to react on short notice to very large swings in the number of recruits expected to enter the services in the last quarter of the year.

Shocks in Recruiting or Retention Can Produce Multiple-Year Oscillations in the Accession Pattern and in Current Strength. Another implication of eliminating the end-strength goal is that shocks in recruiting can produce undesirable oscillations, over many years, in both accession patterns and the level of current strength. Under the current scheme, if the Navy succeeds in achieving its end-strength goal for the fiscal year—despite a shortfall in shipping for a specific month—the shock will have no impact in subsequent years on either accession patterns or current levels of strength. Figure 6 demonstrates this for a simple model with an end-of-year strength target and level-loading in accessions.

An average-strength scheme, however, creates a long-term recursive pattern in the levels of end-strength and in the levels of recruiting. This recursive pattern is a simple consequence of the fact that average strength is calculated from current strength at the beginning of the fiscal year and that the initial current-strength level is determined by the recruiting patterns of previous years. This is shown in the example presented in figure 7. For this illustration, we assume that the Navy pursues level loading in accessions, setting shippers equal to losses at 5,200 per month, and that the average-strength target is maintained at 315,000 for several consecutive fiscal years (y, $y + 1$, $y + 2$, ...).[9] Early in the second fiscal year, we observe a shortfall in recruiting that results in shippers falling from 5,200 to 4,200, and, as a result, current manning falls below the average-strength target of 315,000. To meet the average-strength goal, it would be necessary to raise current manning above 315,000 later in the year; panel B illustrates that the average-strength goal can be met by increasing current strength to 316,000 by the end of the second fiscal year.

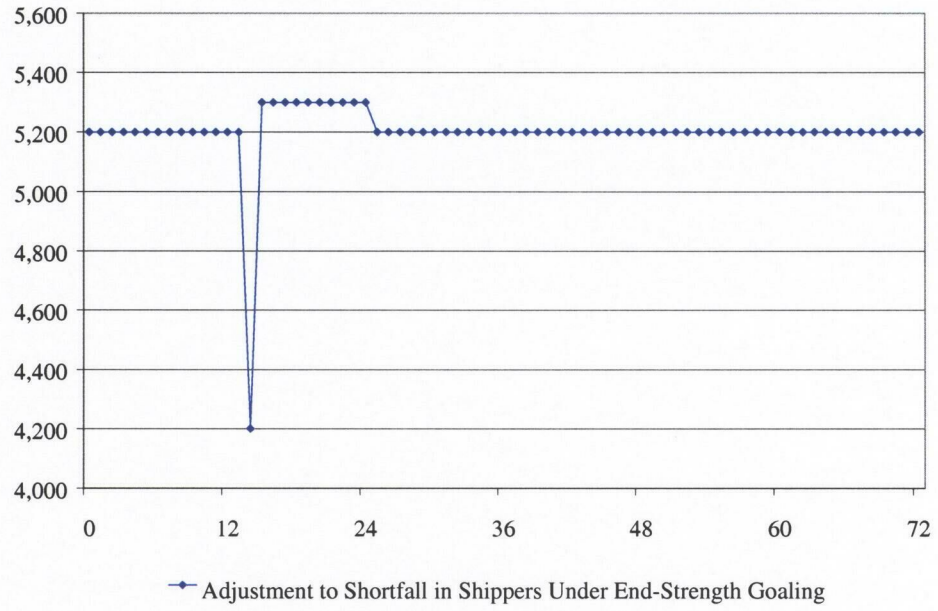
Because the second fiscal year ends with current strength at 316,000, the third fiscal year begins with current strength at this level. As a consequence, current manning would need to be reduced below the average-strength target of 315,000 by the end of the third fiscal year to meet the third-year average-strength goal (it is reduced to 314,154). This recursive adjustment to a shortfall in shipping would continue for many years. In the limit, the process of adjustment could either converge to a steady state, in which patterns of current strength and patterns of accession are repeated year after year, or these patterns could diverge indefinitely.

In later sections of this report, we discuss some of the factors that determine how large a set of oscillations would result from shortfalls in recruiting and whether the adjustment process would converge over time. The later in the fiscal year the services wait to offset a shock to recruiting, the greater the long-term oscillations in shipping and current manning. We also find that, when the services are permitted a larger margin of error in achieving the average-strength target, there may be smaller long-term oscillations in shipping and in current manning.

[9] Shocks in recruiting produce the same sorts of oscillations in manning and current strength when the accession pattern resembles the current bathtub. Figure 11 in the appendix illustrates this.

Figure 6

Panel A. Adjusting accessions to a shortfall in shippers under an end-strength manning scheme with level loading. (A period 14 shortfall in shippers is offset over the rest of the second fiscal year. The shortfall has no further effects on accessions or strength after the end of the second fiscal year.)



Panel B. Current and average strength adjusted to a shortfall in shipping under an end-strength manning scheme with level loading.

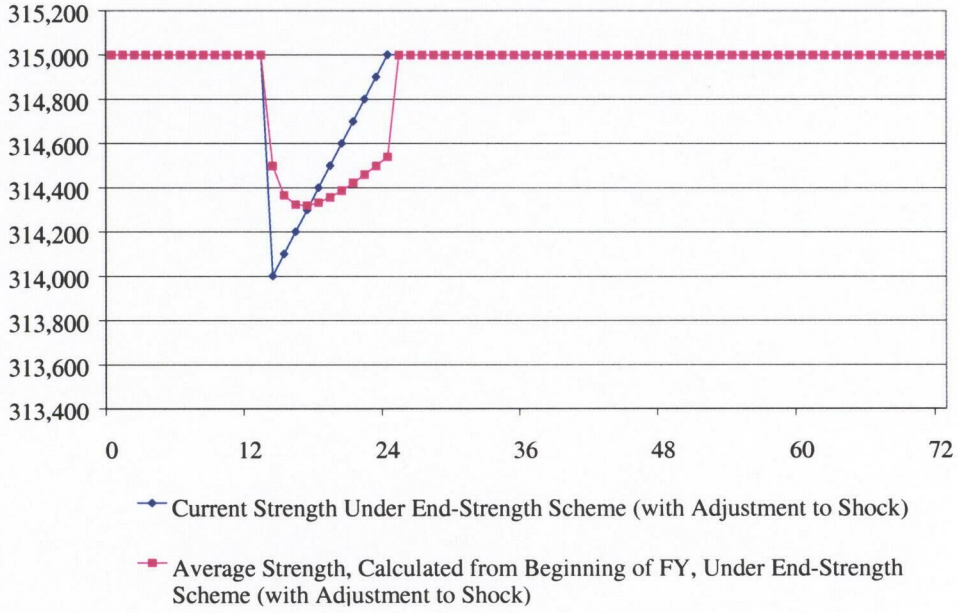
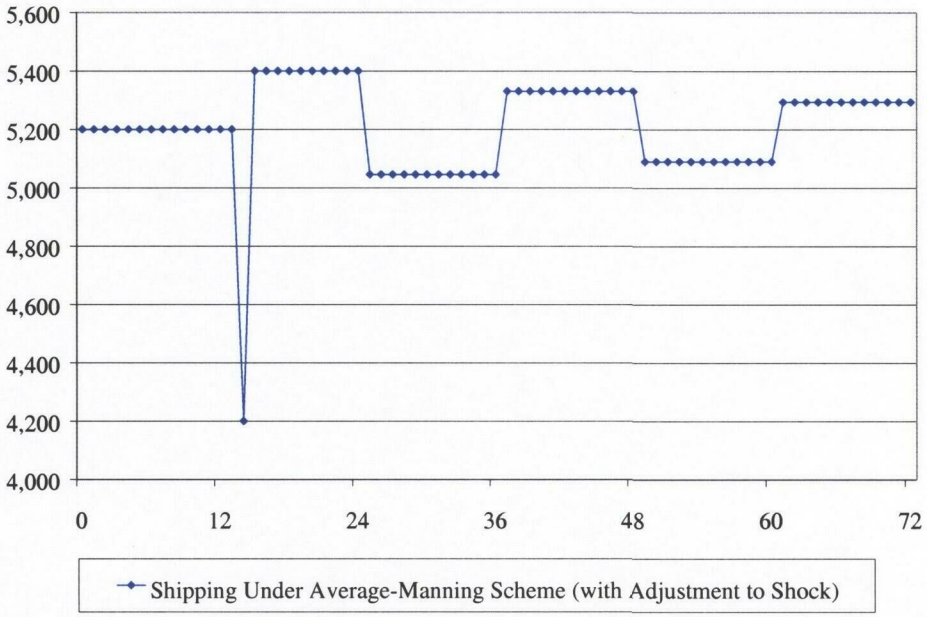
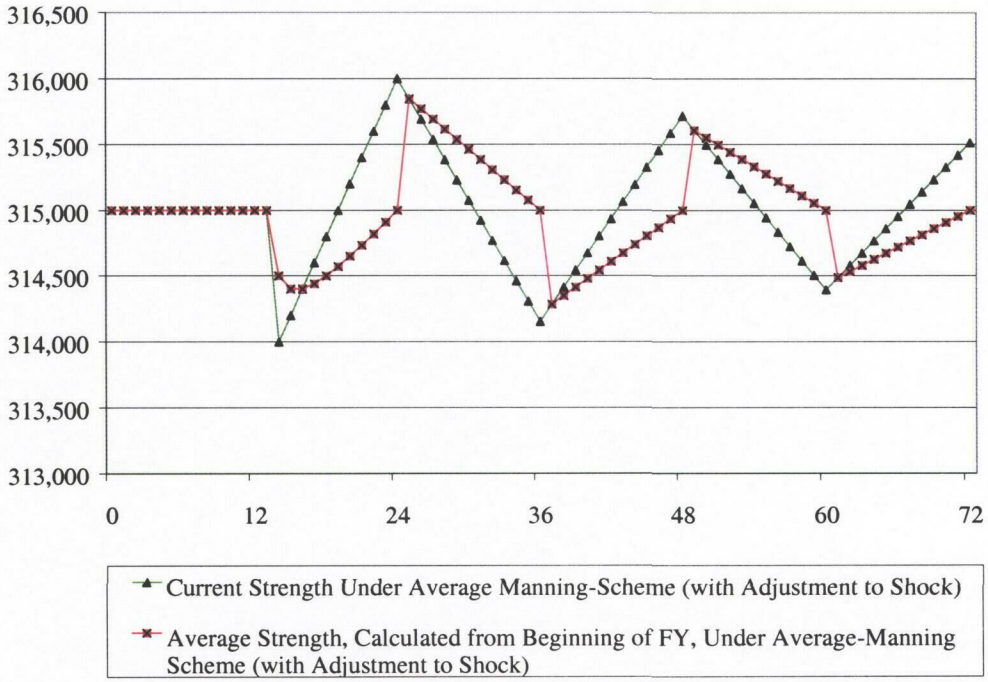


Figure 7

Panel A. An accession profile for an adjustment to a 1-month shortfall in shippers under an average-strength scheme with level loading



Panel B. Levels of current strength and average strength for an adjustment to a 1-month shortfall in shippers under an average-strength scheme with level loading



WOULD THE TIMING OF A SHOCK, OR THE TIMING OF AN ADJUSTMENT TO A SHOCK, AFFECT THE SIZE OF OSCILLATIONS?

Yes, timing would have an important effect on the size of oscillations. Specifically, shocks that occur earlier in the fiscal year would have a greater effect on average strength and would require larger adjustments in end-strength to meet the average-strength goal. Similarly, the longer in the fiscal year that one waits to adjust to a shock, the greater the adjustment in end-strength one would need to achieve the average-strength goal. It is the size of the adjustment in end-strength that determines the magnitude of the oscillations in manning and accessions that result from a shock in recruiting or retention.

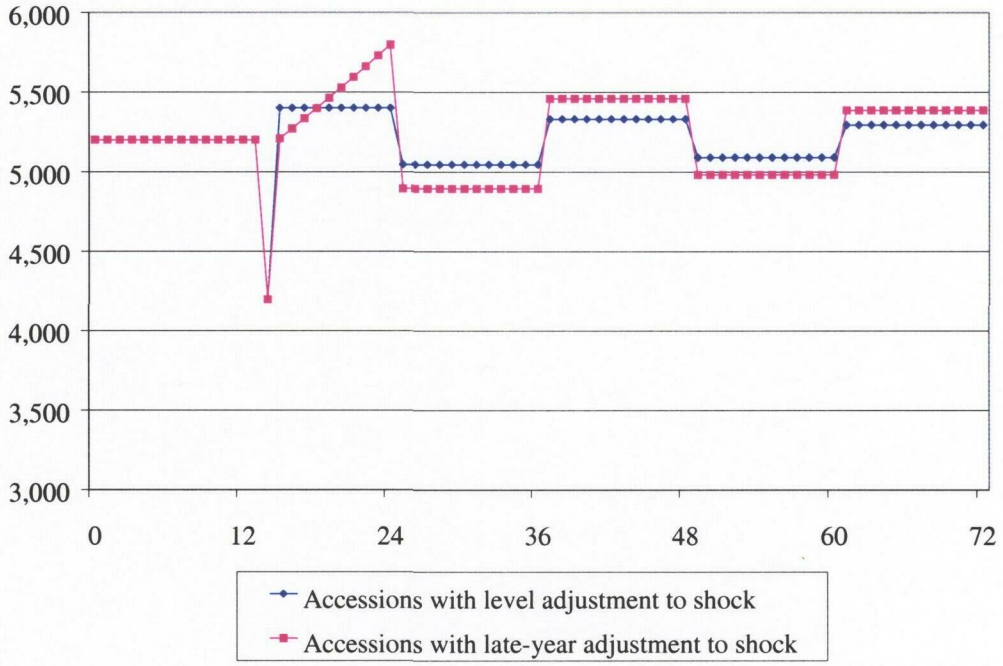
Earlier, we indicated that a necessary condition for an accession pattern to be repeated year after year is that it must produce a level of current strength at the end of the fiscal year that is the same as the current strength that had prevailed at the beginning of the fiscal year. A similar observation can be made about the size of oscillations that occur in accessions and current strength as a result of shortfalls in recruiting: after a shock in recruiting, oscillations will be lessened by anything that *reduces the difference* between current strength at the end of the fiscal year and the current strength that had prevailed at the beginning of the fiscal year.

Figure 8, panels A through C, illustrate this point. The later in the year one waits to adjust to a shortfall in recruiting, the greater the oscillations one observes across years. In figure 8, the blue lines are associated with a level-loaded adjustment to a shock; after a 1,000-person shortfall in shipping in period 14, accessions are increased by 200 per month until the end of the year. Accessions in the following year are the same in every month, but at a lower level (this adjustment to a shortfall in recruiting is identical to that illustrated in figure 7). The red lines in figure 8 show an adjustment that is relatively small early in the fiscal year but that increases throughout the year. We see that this latter case is associated with much larger swings in accessions and current strength.

The rationale for this is straightforward: the later in the year one waits to make an adjustment in accessions, the more people one must ship to make the adjustment. Moreover, the more recruits needed to make the adjustment, the greater the difference between current strength at the end of the fiscal year and the level of current strength that had prevailed at the beginning of the year—and the greater the oscillations one will observe over consecutive years. If, under an average-strength scheme, most shocks were to occur early in the fiscal year, and if it took several months to make offsetting adjustments in accessions, the year-to-year oscillations that we observe could be quite substantial.

Figure 8. Late-year adjustment to a shortfall in recruiting

Panel A. Accession under a level-loaded adjustment and a late-year adjustment to a shortfall in accessions



Panel B. Average strength under a level-loaded adjustment and an end-of-year adjustment to a shortfall in accessions

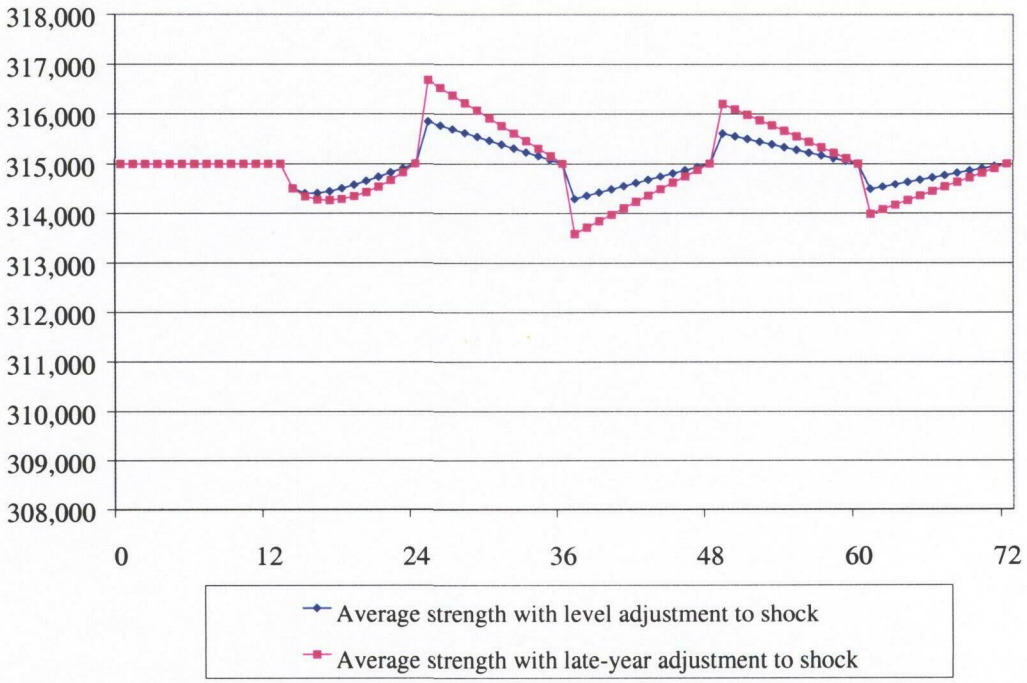
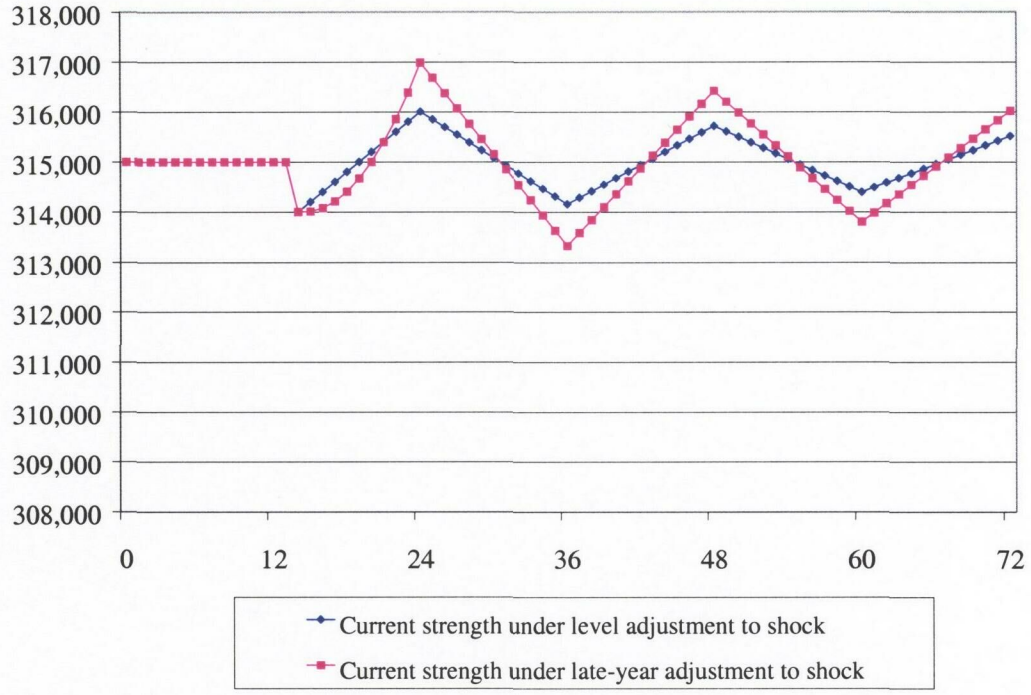


Figure 8, Continued

Panel C. Current strength under a level-loaded adjustment and a late-year adjustment to a shortfall in accessions



UNDER AN AVERAGE-STRENGTH SCHEME, WOULD ONE SET THE MARGIN OF ERROR IN THE SAME WAY AS UNDER AN END-STRENGTH SCHEME?

No. Under the current end-strength scheme, the services are permitted a margin of error of 1 percent below, and 0.5 percent above, their end-of-year strength target. This margin is a useful policy tool because it helps determine the likely range of end-of-year force strength. Under an average-strength scheme, however, the role of the margin of error would likely be much more complex; not only would it help determine the likely levels of average strength, it would also affect the size and frequency of year-to-year oscillations that one observes as a result of recruiting shocks and the degree of variability that would be observed in summer shipping.

Both the timing and the size of shock would affect the optimal margin of error. One of the principal ways in which constructing a margin of error would be different under an average-manning scheme is that one would need to consider both the *size* and the *timing* of the recruiting shortfalls that one is likely to encounter. To illustrate this, consider how one would construct a margin of error that is intended to allow for a *single* shortfall in recruiting of 1,000, which occurs during some single month in the fiscal year.

Under an end-of-year strength scheme, this would be straightforward: one would simply establish an end-strength margin of error of 1,000 recruits around the end-strength goal. Under

an average-strength scheme, however, the margin of error that one would need around the average-strength goal would be a function of when in the fiscal year the shortfall occurs.

In table 1, the values under Month 12 indicate that a shortfall of 1,000 shippers that occurs in the last month of the fiscal year would imply a deficit of only 83.33 (1,000/12) in average strength. The small size of this deficit in average strength reflects the fact that the missing shippers would have served only 1/12 of a year and, as a result, would have made a relatively small contribution to average strength. Only if the shortfall in shipping were to occur in the first month of the fiscal year would the necessary margin of error for the average-strength target equal 1,000: in this case, the missing shippers would have served a full year and—if we ignore first-year attrition—their contribution to average strength would equal their contribution to end-strength.

Table 1. The end-strength and average-strength margins of error necessary to permit a singe shortfall of 1,000 shippers during various months of the year

	Month											
	1	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**
End-Strength Margin of Error	1,000	1,000	1,000	1,000	1,000	1,000	1,000	1,000	1,000	1,000	1,000	1,000
Average-Strength Margin of Error	1,000	917	833	750	667	583	500	417	333	250	167	83

Table 1 illustrates the following scenario: were the services to shift from an end-strength target to an average-strength target, the average-strength margin of error would probably not need to be as large as the current end-strength margin of error. One can, given some stringent assumptions, establish a margin of error around an average-strength target that is equivalent to a specific margin of error around an end-strength target (equivalent in the sense that the services would be just as likely to achieve the margin of error around average strength as to achieve the margin of error around end-strength). For example, if shortfalls in shipping were equally likely to occur in any month, and if there were typically level loading in accessions (implying that end-strength is expected to equal the average-strength target), an average-strength margin of error of ±13/24*1,000 would be equivalent to an end-strength margin of error of ±1*1,000.[10]

If shocks in recruiting are more likely to occur early in the fiscal year, or if the accession pattern were to become more front-loaded under an average-strength scheme, one would require a larger margin of error around average strength for the services to achieve goal with any specified probability. One can construct simulations in which a larger margin of error would be needed for an average-strength scheme than for an equivalent end-strength scheme, but these reflect

[10] Such an average-strength target can be calculated by observing that the series (1 + 11/12 + 10/12 + ...)/12 sums to 13/24.

extreme circumstances. It seems reasonable to set the margin of error for an end-strength scheme as the upper bound on the margin of error for an equivalent average-strength scheme.

The margin of error that one would ultimately wish to adopt would be a function of several factors, including (1) the proportion of time that one wishes to be within the margin of error, (2) the accession pattern to which the service would ultimately shift under an average-strength scheme, (3) the likelihood of shocks that one would observe at different times of year under the new accession plan (are shortfalls in recruiting more likely to occur early or late in the year?), and (4) the *correlation* of shocks that one would observe under the new accession pattern (are poor recruiting months likely to be followed by good or bad recruiting months?).

CAN A LARGER MARGIN OF ERROR *REDUCE* THE YEAR-TO-YEAR OSCILLATIONS IN ACCESSIONS AND END-STRENGTH THAT RESULT FROM SHORTFALLS IN RECRUITING?

Yes. We have previously seen that, after a shock in recruiting, oscillations will be lessened by anything that reduces the difference between current strength at the end of the fiscal year and the current strength that had prevailed at the beginning of the fiscal year. Under the current staffing scheme, oscillations do not occur because end-strength is mandated to return to its legislated level. With an average-strength scheme, however, there are no such restrictions on end-strength and the only policy instrument that would be available to limit oscillations from one year to the next would be size of the margin of error around the average-strength goal. Figure 9, panels A through C, illustrate how the margin of error influences the size of interyear oscillations in current strength and accessions.

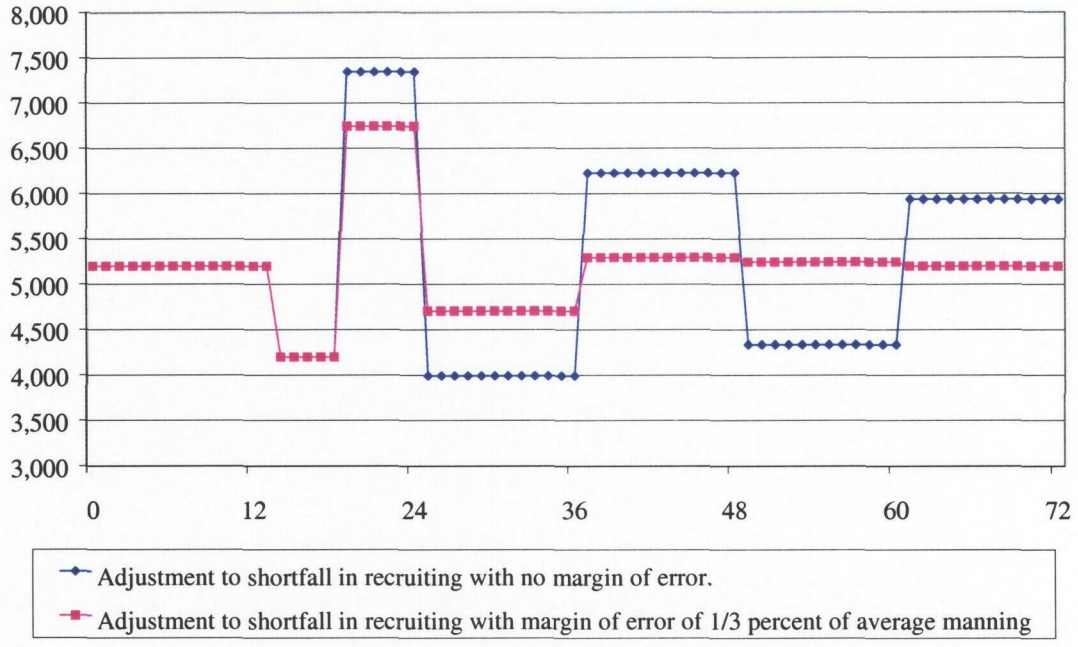
To make the illustration easier to follow, we assume a level-loading scenario in which the Navy sets monthly shipping equal to monthly losses at 5,200 and plans for current strength to equal average strength at 315,000 persons. (The key results of this simulation are the same as if the example were based on the approximation to the current accession pattern). In periods 14 to 18, there are shortfalls of 1,000 shippers per month; only 4,200 recruits are sent to bootcamp in each of these months. From the end of month 18, the illustration shows two methods of adjusting to the shocks. The blue lines are associated with an adjustment when there is no margin of error around the average-strength target of 315,000. The red line is associated with an adjustment when there is a margin of error of 1/3 of 1 percent around the average-strength target (average strength levels of 313,950 to 316,050 are considered within range).

We see that in the year of the shock in recruiting, the readjustment without a margin of error requires end-strength to be increased to 322,858 to offset the shortfall and to meet the average-strength goal of 315,000. A much smaller readjustment is required when the margin of error is at 1/3 percent: an end-strength of 319,257 would be sufficient to raise average strength to 313,950 (the bottom of the margin of error).

For the case with a positive margin of error, in each of the subsequent years, current manning at the end of the year is closer to the current manning that had prevailed at the beginning of the year because smaller readjustments in strength were required to fall within the margin of error. It is again worth stressing that anything that brings the level of current strength at the end of the year closer to that which had prevailed at the beginning of year reduces the size of oscillations.

Figure 9

Panel A. Accessions in an adjustment to a shortfall in recruiting under an average-strength scheme with level loading



Panel B. Average strength in an adjustment to a shortfall in recruiting under an average-strength scheme with level loading

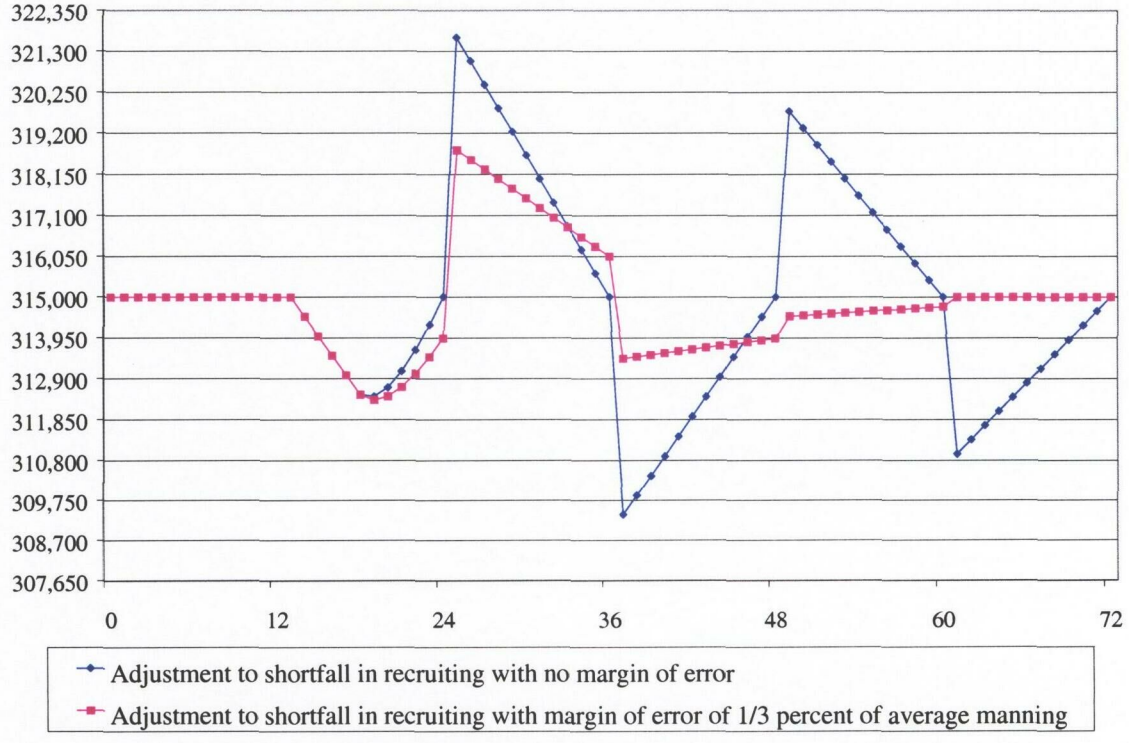
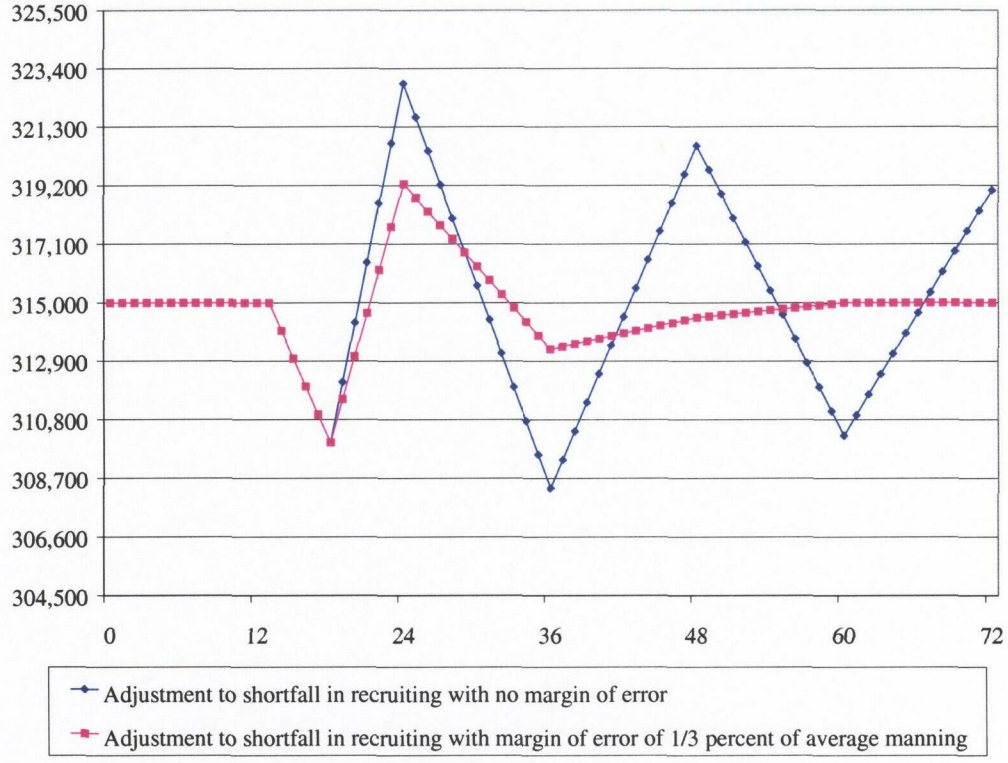


Figure 9, Continued

Panel C. Current strength in an adjustment to a shortfall in recruiting under an average-strength scheme with level loading



CAN HAVING A MARGIN OF ERROR INDUCE DRAWDOWNS IN SUMMER SHIPPING AND *PRODUCE* INTERYEAR OSCILLATIONS IN STRENGTH AND ACCESSIONS?

Yes. One of the objectives of implementing an average-strength scheme is to eliminate the incentive to draw down on midyear strength to produce savings in the personnel budget (MPN) and, thus, to do away with one of the causes of the "bathtub in fleet manning." However, when one introduces a margin of error into the average-strength scheme, it creates an incentive—under some rather common circumstances—to draw down end-of-year strength.

This situation would exist were policy-makers to construct a margin of error for a shortfall in accessions and were the shortfall not to materialize. For example, if policy-makers anticipated that October shippers would be 1,000 below the optimal accession level, and wished to build this shortfall into the average-strength margin of error for the year, they would increase the permitted deficit in average strength by 1,000. If this shortfall failed to materialize, however, the 1,000-person deficit in average strength would permit the service to save on MPN by drawing down shipping by as much as 4,000 persons in each of the last 2 months of the fiscal year.

Carrying this example a bit further, one can see that introducing a margin of error would not only increase the variability in summer shipping, but would also introduce another cause for interyear

oscillations in accessions and strength. Were the Navy to draw down accessions in each of the last 2 months of the fiscal year by 4,000, they would close the year with current strength well below the level that had prevailed at the beginning of the year. In the subsequent year, beginning strength would be at a low level and this would imply the need for unusually high recruiting throughout the year and the need for an unusually high level of end-strength. This sort of recursive adjustment would continue year after year.

This example suggests that the larger the margin of error constructed by policy-makers, the greater the services' capacity to save on MPN by drawing down on summer shippers (a larger margin of error would permit drawdowns in summer strength that are both larger and more frequent). This, in turn, implies that a larger margin of error could cause more sizable and more frequent oscillations in strength and accessions. This result stands in sharp contrast to the finding of a previous section, which indicated that, *once oscillations had begun*, a larger margin of error would help dampen successive swings in strength and accessions. Policy-makers would need to be aware that changing the size of the margin of error could produce countervailing effects on the long-term stability of recruiting and manning if the pitfalls of this strategy are not recognized and avoided.

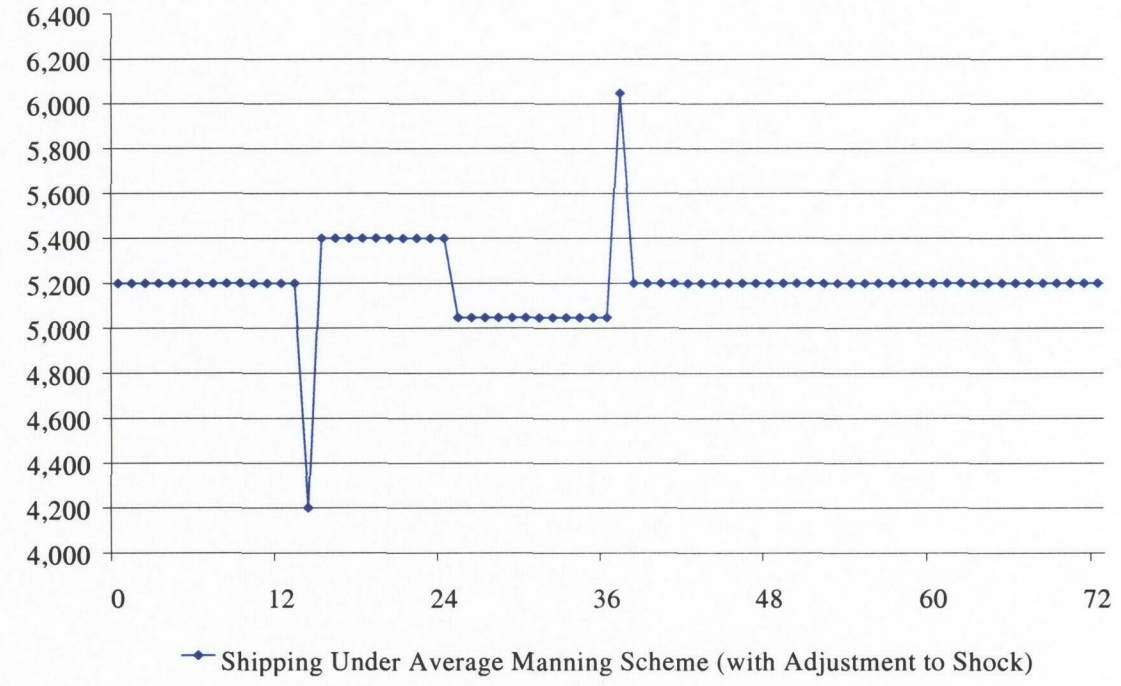
COULD RECRUITING COMMAND USE THE DELAYED ENTRY PROGRAM (DEP) TO REDUCE INTERYEAR OSCILLATIONS IN ACCESSIONS AND STRENGTH THAT OCCUR UNDER AN AVERAGE MANNING SCHEME?

Yes. Recruiting Command could use DEP to limit the length of time that oscillations occur due to an unexpected shock in accessions. We have previously seen that a shock to accessions creates a long-term recursive pattern in the levels of end-strength and in the levels of recruiting. After a shortfall in accessions, current-strength must be increased in the latter part of the year to meet the average-strength goal. The next year starts with a high level of current manning and this, in turn, requires a reduction in current strength in the latter part of that year. This recursive pattern could be broken if, during the time that current strength is being reduced to meet the average manning goal, the service were able to recruit at its normal level and were able to send a significant proportion of recruits into DEP, to be shipped at the beginning of the next fiscal year.

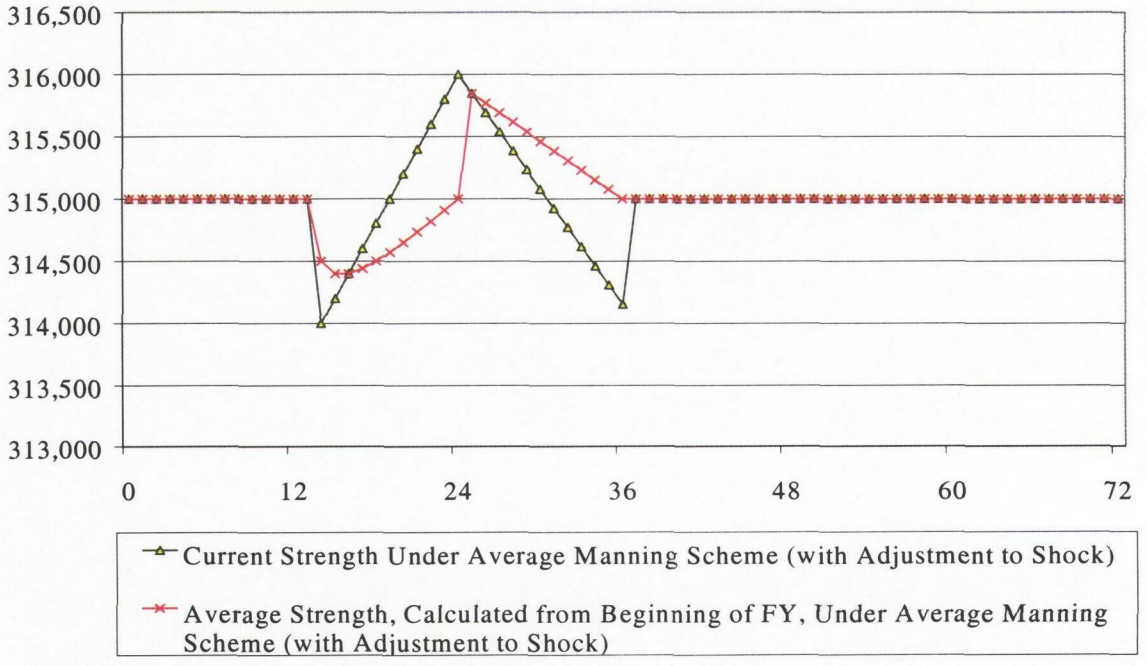
Figure 10 illustrates this point. It shows the same unexpected shock to accessions represented in figure 7: in month 14, accessions unexpectedly decline by 1,000 to 4,200. As a result of this shortfall, shipping is stepped up in months 15 to 24 (from the usual level of 5,200 to 5,400) and must then be reduced in months 25 through 36 (to 5,046). Unlike the previous example, however, we assume that during months 25 to 36 Recruiting Command is able to build up DEP such that it can bring on 846 additional shippers at the beginning of the new fiscal year in month 37 (shippers in month 37 equal 6,046 rather than the usual 5,200). If Recruiting Command were able to use DEP in this way, it could dampen the long-term oscillations in accessions and manning that result from shocks to recruiting. However, two points must be mentioned about using DEP in this way. First, while the Navy might use the DEP to reduce oscillations in "out-years," a shortfall in recruiting could still have a profound impact on the pattern of accessions in the year following the shortfall. Second, it is unclear the extent to which the service could rely on this solution; to our knowledge, the Navy doesn't have an estimate of the number of recruits who would choose not to sign a contract or who would attrite from DEP if they were unable to ship during the preferred summer months.

Figure 10

Panel A. An accession profile for an adjustment to a 1-month shortfall in shippers, under an average-strength scheme with level loading, using DEP to dampen oscillations



Panel B. Levels of current strength and average strength for an adjustment to a 1-month shortfall in shippers, under an average-strength scheme with level loading, using DEP to dampen oscillations



CONCLUSIONS AND IMPLICATIONS

On first consideration, the introduction of an average-strength scheme appears to make a great deal of sense. Under such a scheme, the amount paid to personnel would be proportional to their contribution to meeting the average-strength target. As a result, the introduction of such a plan would eliminate the services' ability to save on personnel costs by drawing-down on strength in the beginning and middle of the year. This, in turn, would eliminate *one* of the incentives to back-load accessions (to ship most recruits to boot camp late in the year) and might result in a more level-loading of accessions. (However, the introduction of an average-strength plan would not change the fact that it is less costly to recruit among high school seniors who only become available for accession late in the fiscal year; it is unclear whether the introduction of an average-strength scheme would actually produce much change in the accession profile.)

Closer analysis suggests that an average-strength scheme has several significant shortcomings. Perhaps the most significant of these is that it would likely produce a sharp increase in the *variability* of summer shipping. Although *average* summer shipping could decline under the new legislation, in some years meeting the goal would necessitate a high level of summer surge—perhaps even higher than the level that is currently observed. In other years, when there is strong availability of shippers early in the year, the services would have less incentive to send recruits to boot camp in the last quarter of the fiscal year. The increase in variability in summer shipping would require training command to respond on short notice to very large swings in the number of recruits expected to enter the service in the last few months of the fiscal year.

Not only would we likely observe greater variability in summer accessions under an average-strength scheme, but we could see significant year-to-year oscillations in both strength and shipping. We have demonstrated that shortfalls in recruiting can have large spillover effects that impel swings in strength and accessions over many consecutive years. These oscillations may be very wasteful of resources: to meet average-strength goals, the services would be forced either to take on many more persons than they require or to allow manning to fall below optimal levels.

Another serious problem with the average-strength scheme is that the policy instruments available to fine-tune its performance are either unproven or are difficult to apply. Adjusting the margin of error around average strength would involve tradeoffs in (1) the precision with which one can plan average strength, (2) the variability in summer shipping, and (3) the size of interyear oscillations that occur in strength and accessions as a result of shortfalls in recruiting. A second policy instrument—extending the period that recruits spend in DEP—might be used to limit the number of years over which a shortfall in recruiting generates oscillations in accessions and strength. However, the practicality of this policy instrument is untested.

An additional concern in adopting an average-strength scheme is that we cannot predict with any precision how the policy would work before its implementation. The adoption of an average-strength scheme might lead to significant changes in the pattern of accessions and would impel the services to recruit from different populations (e.g., there may be greater incentive to recruit from the workforce population). Precise predictions about the functioning of an average-strength scheme would require more information than is currently available on the supply of recruits from these populations at various times of year. We have seen, for example, that both the variation in

summer shipping and the size of interyear oscillations in strength would depend on how large a supply of recruits is available early in the year and on the consistency of this supply. Historical patterns in recruiting, however, tell us little about these things because available time-series data reflect both the demand for recruits (which has been influenced by a strong incentive to back-load shipping) and the supply of recruits under diverse economic conditions, different offers of military pay, and various seasonal differential enlistment bonus schemes.

APPENDIX: A SIMULATION USING A BACK-LOADED ACCESSION PATTERN

This appendix extends some of the simpler simulations of an average-strength scheme presented in the body of this text to a more complex case in which recruiting patterns resemble those that have prevailed over the last ten years. We demonstrate that key findings presented with the simple models generalize to the more realistic and complex model.

We have pointed out that, under an average-strength scheme, there is an incentive to make accessions more front-loaded. We have also pointed out, however, that the supply of high school recruits favors a more back-loaded accession pattern and that we cannot predict the accession pattern that would be realized should the services adopt an average-strength scheme. As a result, it is useful to explore how an average-strength scheme might perform using the current back-loaded accession pattern as a benchmark.

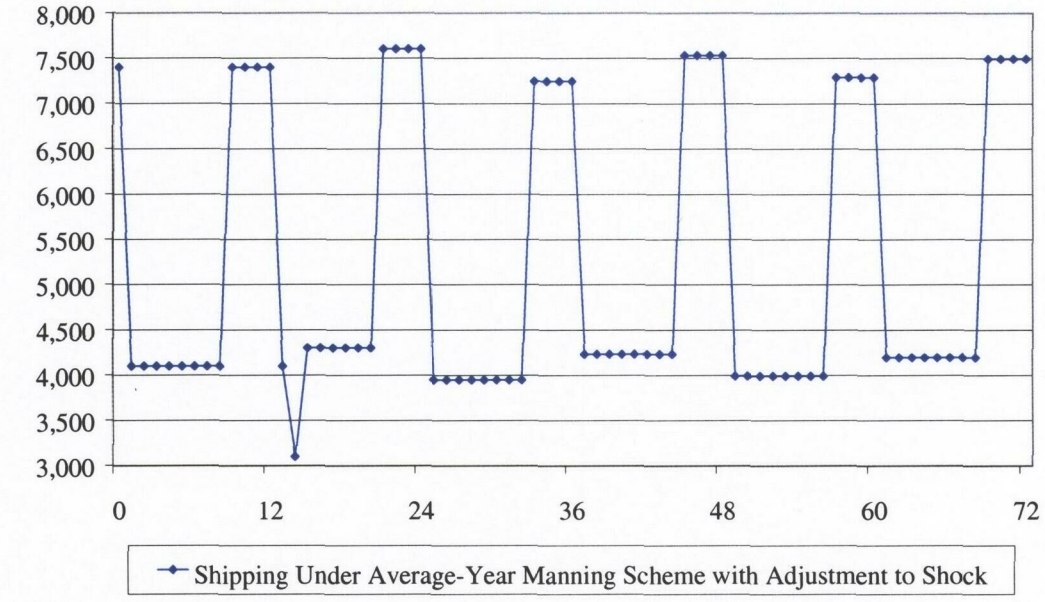
Figure 3, panel A, in the body of this report shows an approximation of the current accession pattern in which 4,100 recruits are shipped in each of the first 8 months of the fiscal year, and 7,400 recruits are shipped in each of the last 4 months of the fiscal year. In panel B of this figure, we show the current-strength levels that would correspond to this accession pattern, given an initial strength of 315,000 and a constant loss pattern of 5,200 persons per month. These values for beginning strength, accessions, and losses are consistent with average strength of 310,600 and an end-strength of 315,000 for each year. Because the accession path yields a current strength at the end of each year that is equal to current strength at the beginning of that year, the shipping pattern can be replicated over consecutive years.

Figure 11 demonstrates what happens when the shipment of recruits falls below target under this accession pattern. (We will compare this with the response to a shortfall in recruiting under an average-strength plan with level-loaded accessions, represented in figure 7 in the body of this report.) In period 14, there is a shortfall in accessions of 1,000: rather than shipping 4,100 in this month, only 3,100 are sent to bootcamp. To offset this deficit, shipping is increased by 200 per month for each of the ten remaining months of the fiscal year; as a result, the service meets its average-strength target of 310,600. Current strength at the end of the year, however, is 316,000—1,000 above current strength at the beginning of the year.

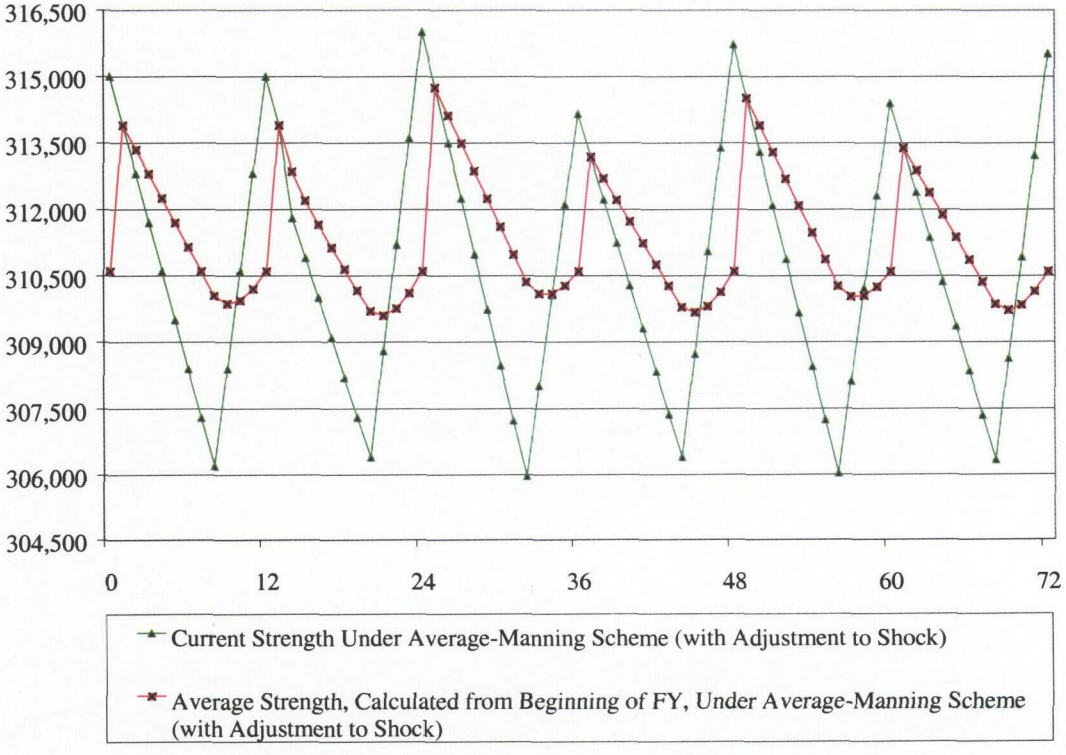
Because the second fiscal year ends with current strength at 316,000, the third fiscal year begins with current strength at this high level. To achieve the average-strength target of 310,600 for this period, shipping over the third year is reduced below the planned accession pattern: in the first 8 months of the year, accessions would be set at 3,946 (rather than 4,100); in the last 4 months of the year, accessions would be set at 7,246 (rather than 7,400). Average strength would again be achieved, but current strength would decline to 314,154 (compared to 316,000 at the beginning of the third fiscal year and 315,000 at the beginning of the second fiscal year).

Figure 11

Panel A. Accessions adjusted to a period 14 shock in recruiting under an average-strength scheme with approximation of the current accession pattern



Panel B. Average strength and current strength adjusted to a period 14 shock in recruiting under an average-strength scheme with approximation of the current accession pattern



The key point in this example is that the end-of-year strengths shown in figure 11 are identical to those shown in figure 7. The oscillations that we observe in end-strength under an average-strength scheme are the same whether the service uses a level-loading accession pattern or an accession pattern with a summer peak.[11]

[11] Note that in both the simulation illustrated in figure 7 and that illustrated in figure 11, the service responded to the period 14 shortfall of 1,000 recruits by raising shipping by a constant amount (200 persons) in months 15 to 24. It is because the patterns of adjustment were the same in the two cases, that we observed identical oscillations in end-strength in the two examples.

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